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SCIENCE

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ORGANIZATION OF AMERICAN SCIENTISTS FOR THE WAR[1]

By Dr. KARL T. COMPTON

PRESIDENT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

INTRODUCTION

IN ordinary times any American scientist would deem it a distinguished honor to be nominated as the Pilgrim Trust lecturer. In these extraordinary times the significance of this lectureship is enhanced by the fact that American and British scientists are working hand in hand, not only to advance science as an important aspect of man's culture, but now especially as a powerful tool for the preservation of our opportunities for continued life, liberty and pursuit of happiness. Consequently, when Sir Henry Tizard transmitted your invitation for me to deliver this lecture I accepted the invitation with profound appreciation and humility.

There were also two personal aspects of this invitation which aroused in me a sentimental reaction. The establishment of the Pilgrim Trust lectures was announced to the Royal Society by your late colleague, Sir William Bragg, in his presidential address at the anniversary meeting of the society in 1937. Not only has Sir William Bragg, together with his distinguished son, been an inspiration to my generation of American physicists, but it happens that he delivered the address at the graduation exercises of the Massachusetts Institute of Technology on the occasion of my inauguration as president of that institution in 1930. I recall very vividly his remarks on that occasion and my feeling that his presence was an inspiration to me at that time when, with considerable trepidation and regret I moved from the research laboratory into an administrative office.

In that address Sir William traced the development of modern institutions for technical instruction and drew his illustrations from the lives and work of

[1] Pilgrim Trust Lecture, under the auspices of the Royal Society of London, London, May 20, 1943.

Count Rumford, Thomas Bernard and Michael Faraday. Permit me to read several excerpts from Sir William's address.

> A school of technology is an expression of the wish to gather together the growing knowledge of nature, of natural materials and laws, and to make that knowledge of service to mankind. . . . Where and when did this movement begin?
>
> It is not of great antiquity. Perhaps the seventeenth century includes its first recognizable appearance, marked by the new-found delight in careful experimental examination of the world. The Royal Society of London was founded in the troubled times of conflict between King and Parliament: where we read the account of the early proceedings of the society we are reminded of boys let out of school, running quickly to brook and hedgerow to examine the extraordinarily interesting things to be found there at every turn. A very important account of the methods of ventilating mines in Belgium comes next to the careful description of some animal monstrosity such as a calf with more than the proper allowance of heads or legs. The professor of astronomy at Oxford writes on the use of incubators in Egypt. Early discussions on tide prediction, then a very important matter because the old harbors did not easily accommodate the large boats wanted for the American trade, lie side by side with a disquisition on a remarkable set of teeth and pertinent references to the properties of sugar. The hodge-podge is readily understandable. The infant was beginning to notice and ask questions. . . . We can well be amused at all this, remembering that the infant has now become a very sturdy youth: and that the proceedings of these early fellows of the Royal Society were only the first results of the new regard for natural knowledge.

Sir William then proceeded in most interesting fashion to sketch the significant facts in the life, work and social viewpoint of Count Rumford and Thomas Bernard, and pointed out that the wealth of Bernard and the stimulation given by Benjamin Thompson, both of them men who spent their early lives within a few miles of my home in Massachusetts, led to the establishment of your Royal Institution.

Then, after drawing lessons from the life of Michael Faraday, Sir William concluded with these words.

> Science was not merely a collection of inventions to be applied by the rich for the comfort of the poor. It was a glorious purpose to be shared by all mankind. We must try to understand the world in which we live, for our own enjoyment, for the training of our minds, for the enrichment of our souls' contemplation, for the means whereby we may help each other.
>
> It is in this spirit that we may try to do our work. It is true of course that we must work for ourselves; instructors have to earn their living and students must come to learn how to earn theirs. As the world is made it must be so, but also the world is so made that the vision of its wonder and of the delight of mutual service and the happy task of exploring the one to help us in achieving the other, can light our lives for us as the sunshine lights the earth.

As we think of the noble ideals which Count Rumford, Thomas Bernard and Michael Faraday held for science as that which "can light our lives for us as the sunshine lights the earth," it is a grim and discouraging contrast to see the scientists of the world engaged to-day in developing new instrumentalities for destruction or other instrumentalities for protection against the destruction which would be wrought upon us by the engines of war of our enemies. The fact that this is so is a grim reminder that our skill in statemanship and our art and ethics of Christian living have not kept pace with our ideals. We have no alternative now but to apply our knowledge of science in every aspect to serve us in our struggle for survival and to preserve for us that opportunity for which our race has struggled throughout the centuries—the opportunity to live and work in peace and freedom.

As the second personal note, let me lay claim to scientific kinship with your body as one who might be called a scientific grandchild of another one of your late leaders, Sir Joseph Thomson. We in America affectionately called him "J.J.," as I understand you also did in England, and we look upon him as the progenitor of that tribe of physicists who interested themselves in the conduction of electricity through gases. Taking him as the founder of that tribe, one of the second generation, your Sir Owen Richardson, was my guide and inspiration during my graduate student years at Princeton University. For his sake I am sorry that I did not turn out to be a more productive pupil, but the interests and satisfactions I have had in the field of research I owe more to him than to any other man.

As you know, we in America have two principal scientific societies which are broadly representative of all the fields of science and which are rather parallel to two of your principal scientific bodies, the Royal Society of London and the British Association for Advancement of Science.

Dr. Frank B. Jewett, president of our National Academy of Sciences, has asked me to deliver his personal message to the president of the Royal Society of London, Sir Henry Dale, and in addition he requested me to express to you the admiration which is felt by the members of the National Academy of Sciences for the magnificent manner in which the scientists of Great Britain have thrown the whole weight of their energies and abilities to master the innumerable technical problems arising in this war. He wanted me to assure you that in so far as we can do likewise, we in America are making a sincere effort to handle our similar problems and cooperatively to supplement the great work which you are doing.

Dr. Isaiah Bowman, last month elected president of the American Association for the Advancement of Science, also gave me a message of greeting to British scientists from which I quote as follows:

Now that the war has advanced to the stage at which we begin to talk of post-war plans, we feel more than ever the need for collaboration between Great Britain and the United States. While there is no such thing as an Anglo-American bloc in world politics there is such a thing as close comradeship in the fight for principles. This comradeship we feel whenever we deal with the leaders of Britain and whatever the field of interest.

I venture to predict that, whatever difficulties may arise, we shall find that comradeship and agreement upon principles will ever mark our future relations. This belief is based upon our widely recognized common responsibility for the peace and safety of mankind in the years after the war. If England is being changed by the war the United States is changing just as rapidly. Once our President was able to report on "the state of the Union," as our Constitution provides, almost without touching on foreign affairs. Two world wars have changed both the tenor and the scope of such messages. The state of the Union now includes the state of the world.

This conception of the state of the Union lays new obligations upon us all. The scientist can no longer report on the state of the sciences. He must report on the impact of science upon society. He must make use of the qualities of mind that science fosters in dealing rationally with the terrible waste in vital resources that war imposes upon the human species. We may hope that the day will soon come when every mature man and woman will feel himself responsible for the state of the Union and act responsibly in that sector of our common life committed to his care, no matter how small the sector may be, no matter how humble.

We say these things while recalling again how great an inheritance they represent from the unfolding political life of Great Britain. No one can speak of liberty and political responsibility and community enterprise without echoing truths that were discovered by centuries of experiment and experience on the part of rulers and ruled in the English political system. Thus, no matter where one starts in estimating future problems and future responsibilities, one ends by recognizing the special bond between America and Britain, by acknowledging the rich inheritance that has been responsible for so many strong elements in American life, and by elevating the comradeship that we both feel and need.

And now I come to the subject of my address. I have chosen to speak on a subject pertinent to the war, to describe to you the manner in which American scientists have organized to make their contribution to the same cause which has mobilized your efforts. In so doing, I trust that I shall be within the spirit, if not the letter, of Sir William's directive for these lectures. For he said, "Such lectures would associate workers in a common task," and surely our common task right now is to direct our scientific resources for victory.

In these days, when numbers of scientists are crossing the Atlantic in both directions on special missions, a better understanding of each other's organizations may be practically helpful. For I frankly confess sympathy with one of your number who recently told me that he found the American organization of interrelated scientific groups a bit complicated. I can only draw cold comfort from the fact that, complicated as it is, the scientific organization is far simpler than that of our governmental departments and bureaus generally. But that is another story.

Peace-time Organization of Scientists in the United States

Let me first give an over-all picture of the scientific and technical organizations of the United States as they exist in peace-time. After this brief review I shall pass to a discussion of the special scientific organizations for war, which is the subject of more particular interest to us at this time.

The scientific and engineering work in the United States may be discussed under three categories: first, the agencies of the Federal Government, exclusive of the Armed Services; second, the agencies within the Armed Services; and third, the non-governmental agencies.

Federal Bureaus. The scientific services of the Federal Government in peace-time are spread through about 40 federal bureaus, of which 18 can be called primarily scientific. Their operations involve only about half of one per cent. of the total peace-time federal budget, but their work is of course absolutely essential to the national welfare in agriculture, manufacture, commerce, health and safety. The personnel of all these bureaus operates under the Civil Service.

From point of view of size of personnel and budget, the scientific services under the Department of Agriculture stand first in the list. Probably these scientific establishments, however, are not as well known generally as those of some of the other departments because their research work is quite largely spread through a great number of agricultural experimental stations distributed throughout the various states of the union and operated cooperatively between the Federal Government and the States. Most of the bureaus in Washington are primarily of an administrative character, but there are several which also conduct centralized research, as, for example, the Bureau of Chemistry and Soils and the Food and Drug Administration. Until recently the U. S. Weather Bureau operated under the Department of Agriculture, but a few years ago it was transferred to the Department of Commerce, largely because the requirements

of air transportation had taken the lead in demanding more accurate and refined methods of weather forecasting than those which had served reasonably well in the past to provide for the needs of agriculture.

Many of you will probably recognize some of the more important of these governmental scientific bureaus, as, for example, the National Bureau of Standards under the Department of Commerce, the Geological Survey, the Bureau of Mines and the Bureau of Mineral Statistics and Economics under the Department of the Interior, and the National Institute of Health under the U. S. Public Health Service.

Of particular interest because of its unique character is the National Advisory Committee for Aeronautics, which was established during the last war and which operates three great research establishments. Until recently the work of the NACA was centered in the aerodynamical research program at Langley Field, Virginia. Several years ago there was added another aerodynamical research establishment named the "Ames Laboratory" at Moffett Field, in California, and quite recently still another large research and development establishment for aircraft engines in Cleveland, Ohio. Also, under the NACA, there are currently some 80 research projects being carried on at universities under contract. This obviates unnecessary duplication of facilities in a government laboratory and maintains a group of university scientists and engineers in close contact with the problems of aeronautical research.

The administration of this organization is also unique among our federal scientific agencies in that its controlling body is a committee which serves without salary and has been composed of men of such high character and distinction as to render it completely free from political influence. This committee is provided with representation from the most interested branches of the Army, Navy and governmental departments, but the chairman and the majority control reside in a body of citizen scientists appointed by the President who, in practice, has followed the recommendations of the chairman in appointments to fill vacancies. The present chairman of the NACA is Professor J. C. Hunsaker, head of the departments of mechanical and aeronautical engineering at the Massachusetts Institute of Technology, and incidentally, while a very young man, the designer of the first American airplane to fly the Atlantic.

Turning now to the United States Armed Services, I can best describe their research and development work as principally a cooperative effort between the services themselves and American industrial companies, with occasional participation from the research laboratories of the technological and educational institutions.

Army. Each branch of the Army contains a technical division under which operate laboratories or arsenals in which a certain amount of research and development work is carried on but whose activities consist for the most part of testing and proving new war materials or equipment. Thus the technical staffs in the various branches of the Army and Navy have the threefold duty of planning and coordinating an extensive program of research and development carried on in the industrial laboratories, of organizing and conducting research programs in their own establishments, and of carrying on the extensive operations of proving and testing which result in the acceptance of new devices and the drafting of specifications for production orders.

Among the principal Army establishments in which such work is centered, I would mention particularly those falling under the Ordnance Department, the Signal Corps, the Chemical Warfare Service and the Army Air Forces. The Ordnance Department operates a great proving ground at Aberdeen, at which is centered most of the proving and testing of ordnance and research on ballistics for arms of all types. In addition it operates five principal arsenals. The Watertown Arsenal is concerned principally with the manufacture of mounts for large caliber guns and is the principal center for research and technical service in the field of metallurgy. The Picatinny Arsenal is devoted to the testing of explosives and the design and operation of pilot plants as guides to the industrial producers. The Rock Island Arsenal carries on research and development in the field of oils and lubricants. The Frankford Arsenal supplements the Aberdeen Proving Ground as a testing and a development center for small arms. The Tank Arsenal in Detroit is the center for the design and testing of tanks.

In the Signal Corps the technical division is divided into three principal branches: the Ground Signal Branch, the Electronics Branch and the Aircraft Radio Branch. The research, development and testing work carried on under the Signal Corps is divided principally between the signal laboratories at Fort Monmouth, Camp Evans, Camp Coles, Eatontown and Toms River. The Signal Corps also maintains a large cooperative establishment working with the Army Air Forces at its principal center, Wright Field.

Until quite recently the research and development work of the Chemical Warfare Service was centered in its great Edgewood Arsenal. As the threat of war came closer, however, a few years ago, and since a

very large portion of the facilities at the Edgewood Arsenal are taken up by production, the Chemical Warfare Service established a subsidiary research laboratory and took over for this purpose the newly erected Chemical Engineering Laboratory of the Massachusetts Institute of Technology.

Despite the great expansion of the Army Air Forces, this service has continued to concentrate its research, development and testing activities at its huge establishment at Wright Field in Ohio. There are of course many other centers at which extended service testing goes on, or at which new equipment is installed in aircraft, but Wright Field remains the headquarters for the research and development work of the Army Air Forces.

The coordination among all these various technical services of the Army is maintained by two types of agency. Within each branch of the Army is a board which has general supervision over technical matters within that branch. Examples are the Coast Artillery Board and the Army Engineers Board. When a project has been approved by one of these boards it is next passed upon by the appropriate Technical Committee, composed of members of this branch of the service, and other branches which may be concerned with the project. If this technical committee also approves the project it goes as a recommendation to the general staff which presumably issues the appropriate directive.

Mention should be made also of the Army Medical Corps, within which a significant amount of research is conducted under the general supervision of the Surgeon General of the Army.

Navy. The Naval Observatory and the Hydrographic Office, which are under the Chief of Naval Operations, have obvious functions in research and development work. The Marine Corps does some research, but naturally depends to a large extent on the Army and the various Bureaus of the Navy. All the Bureaus of the Navy Department, Ships, Ordnance, Aeronautics, Naval Personnel, Supplies and Accounts, Medicine and Surgery, Yards and Docks, do research and development work, though naturally the materiel bureaus conduct the greatest volume.

All research work of the Navy Department is tied together through the office of the Coordinator of Research and Development, which office also arranges coordination with the Army, with other government departments and with the numerous civilian agencies which I will mention later.

Under the Bureau of Ships the Naval Research Laboratory near Washington is a center for all matters of fundamental research, including radio, electronics, chemical warfare defense, etc. The David W. Taylor Model Basin, also near Washington, is the primary station for research and development of ship structures, propeller and hull design. The Naval Boiler and Turbine Laboratory at Philadelphia is concerned with all matters of boiler research, testing and design, including fuel, composition, quality and nature of boiler fuels, ceramics, etc., and also for research, test and development of main propulsion turbines. The U. S. Naval Engineering Experiment Station at Annapolis, Md., is assigned all problems of research, test and development of mechanical equipment in ships other than main propulsion, and it also has a well-equipped Diesel engine laboratory. The principal metallurgical laboratory for the Bureau of Ships is also located at the Engineering Experiment Station. In New York there is located the Materials Test Laboratory, which handles all matters of research, test and development of electrical materials and equipment, acoustical equipment, optical and navigational material and equipment, plastics and allied materials. There are rubber and paint laboratories at Mare Island, California, and an inspection test laboratory in Pittsburgh, Pa., where line production methods for chemical analyses are set up which permit a capacity of about 5,000 chemical analyses per week with a minimum of personnel and equipment. In addition to the above each Navy Yard is equipped with an industrial laboratory to serve the purposes of the Yards. It has been found possible to place specialized problems in some of these laboratories such as the development of chain and rope in the Boston Navy Yard. The assignment and progress, as well as general administration of all research, development and test work, is carried out by the Bureau of Ships in Washington in order most fully and effectively to coordinate all work and to collect, apply and distribute the results.

Under the Bureau of Ordnance there are the Dahlgren Proving Ground, the Naval Gun Factory at Washington, whose research department includes the Naval Ordnance Laboratory, the Naval Powder Factory near Washington and the Newport Torpedo Station. In addition there are establishments devoted to mines, counter-mines, nets and the like.

Under the Bureau of Aeronautics there is the Naval Aircraft Factory in Philadelphia, the Cedar Point Flight Testing Field near Washington and the Aircraft Armament Laboratory and Testing Field at Hampton Roads.

Research in medicine and surgery is directed by the Research Division of the Bureau of Medicine and Surgery, using many facilities but largely those of the U. S. Naval Medical Research Institute at Bethesda near Washington and the Medical Research Laboratories at Pensacola and New London.

Civilian Agencies. I pass now to the non-govern-

mental scientific organizations in the United States, most of whose members are attached to the staffs of some 600 colleges, universities and engineering schools, some 2,000 industrial research laboratories and other specialized research institutes. Do not be alarmed when I begin by saying that these comprise well over one hundred nationally recognized scientific and engineering societies, exclusive of the social sciences. Of these, only a few are general in scope in the sense that they cover broadly the entire field of science. Largest of these is the American Association for the Advancement of Science, a close parallel to your British Association, with a direct membership of about 24,000 and an indirect aggregate membership of about a million through the 187 associated and affiliated societies. Of a more exclusive character and without the affiliated and associated societies are the American Philosophical Society and the American Academy of Arts and Sciences.

Unique among the scientific organizations of the United States is the National Academy of Sciences.

In March, 1863, during a crisis of our Civil War, Congress established the National Academy of Sciences and President Lincoln signed the Act of Incorporation. This act specified that "the Academy shall, whenever called upon by any department of the government, investigate, examine, experiment and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments and reports to be made from appropriations which may be made for the purpose." There was also the provision in the charter that, except for the actual expenses of these activities, neither the academy nor any member of the academy is entitled to receive any compensation whatsoever for such services. Although the membership is legally limited to 450, the actual membership in the academy has never exceeded its present enrolment of 350.

Outside of its services in war-times, perhaps the most noteworthy public service by the academy was its geological and engineering investigation of the slides which at one time threatened to prevent the successful consummation of the Panama Canal. However, the utilization of the academy by the government has been rather "spotty." Under some administrations the academy has been used rather extensively and in other administrations has been more or less forgotten by the government. In this respect I believe that your Royal Society has had a more consistent role of usefulness.

One inevitable characteristic of this type of organization, in which membership is considered to be the highest scientific honor of the country, is that membership, like scientific recognition, is likely to come to a man after he has passed the peak of activity in his scientific career. For this reason the academy has been able to perform an excellent function of the "scientific elder statesmen" variety. It has zealously kept itself free from all types of political influence. Its ideals have been unselfish service, integrity and scientific competence. Frequently, however, probably in the great majority of cases, when a very active research program has to be undertaken, many of the personnel best adapted for the particular job are not found within the membership of the academy.

During the last world war in Europe, but before the United States had become a participant, President Wilson by executive order requested the National Academy of Sciences to establish the National Research Council as a measure of national preparedness. This organization operated so usefully during the war that after its termination, in April, 1919, the National Research Council was perpetuated by the National Academy of Sciences at the express request of President Wilson.

This National Research Council is organized into nine permanent divisions covering the various fields of scientific research and of scientific administration. These divisions are composed of appointed members and also of representatives from many of the scientific and engineering societies and branches of the government. Because of this wide representation the National Research Council is a most effective agency for finding just the right persons to do any specific scientific job.

During the present war the National Academy and the National Research Council have been called upon to perform many important services, some of an advisory character and some involving the placing of contracts for research and development work in various laboratories.

Among the nearly 200 committees operating under the National Research Council, the following are typical of those concerned with the war: Aviation Medicine, War Metallurgy, Passive Protection Against Bombing, War Use of Research Facilities, Tin Smelting and Reclamation, Clothing, Shock and Transfusions, Treatment of Gas Casualties, War-time Diet and Selection and Training of Service Personnel.

(To be concluded)

OBITUARY

HENRY SEELY WHITE
1861–1943

HENRY SEELY WHITE, distinguished mathematician and professor emeritus at Vassar College, died on his eighty-second birthday, May 20, 1943, at his home on Overlook Road, Poughkeepsie.

Professor White's early years were spent in Cazenovia, N. Y., where his father, Professor Aaron

White, was principal and mathematics teacher in Cazenovia Seminary. In his seminary years the boy was introduced to farm life on his grandfather's lands and invited to take up that work, but, like Newton, he preferred academic activities to farming, and his chief contribution to the farm consisted of surveying, a task which he appreciated most for its temporary claim. He entered Wesleyan University and was graduated with honors in 1882. Twice he returned there for service, to assist in astronomy and physics the year after graduation, and again in 1884 as registrar and tutor in mathematics after an intervening year of teaching at Centenary College. Frequent trips to Wesleyan in later years and deep interest in its welfare gave testimony to his strong attachment to his Alma Mater and the honorary degree conferred on him at the Wesleyan Centennial in 1932 bespeaks the university's pride in him.

Between 1887 and 1890 Mr. White was at Göttingen in work that led to the doctorate. Here he responded to the stimulus of great mathematicians with a thoroughness and joy which characterized all his work. Whether through the influence of these years of close contact with the minds congregated in that Mecca of the era or through his own natural urge to wider fields, he developed a breadth of view and a catholicity of interest that marked his scholarship through the following years.

At Clark University, to which he was called on his return from European study, and at Northwestern University, where he was chairman of the department, his mathematical stature could be measured by the calls he was receiving to other posts. It was at Northwestern, in 1905, that President James Monroe Taylor, of Vassar College, after a nation-wide search for a distinguished mathematician, found in him the man he sought.

To Vassar's advantage he declined frequent further calls and remained to direct the Vassar Department of Mathematics for thirty-one years, an inspiration to students and colleagues who enjoyed the charm of his personality and the quality of his mind. His dry wit, his courtly bearing and his quiet, gentle insistence on work of substance expressed with clarity brought forth the best in his students. To the college community Professor White and his wife, a musician of note, provided generous hospitality which afforded valuable opportunities for additional acquaintance. They also helped to cement friendly relations between town and gown, Mr. White serving at one time as president of the Poughkeepsie University Club, at another as commodore of the Poughkeepsie Yacht Club, and both entering into various other local activities.

Profesor White was one of the founders of the American Mathematical Society Colloquium Lectures. He served as editor of the *Annals of Mathematics* from 1899 to 1905 and of the *Transactions* from 1907 to 1914. He was president of the American Mathematical Society from 1906 to 1908, president of the American Association for the Advancement of Science in 1915, and was elected fellow of the National Academy of Science in the same year. The degree of doctor of laws was conferred on him by Northwestern University in 1915.

Publications by Mr. White in book form and as contributions to journals were concerned primarily with his interests in the theory of invariants, geometry of curves and surfaces, correspondences, plane and twisted curves, homeomorphic sets of lines in a plane and relativity in mechanics. His best known work was "Plane Curves of the Third Order."

With his vast fund of information Professor White was always ready to explore topics brought to his attention by others, beginners as well as mature workers, and shared his wisdom with genuine pleasure. His colleagues of various departments enjoyed the universality of his knowledge as well as his humor and friendly, constructive cooperation, and they continued to consult him during the years of his retirement from teaching. He never did retire from creative scholarly work nor from his connections with church and city groups, but remained a remarkably active and efficient person to the time of his death.

MARY EVELYN WELLS

VASSAR COLLEGE

ARTHUR TRAUTWEIN HENRICI

1889–1943

DR. ARTHUR T. HENRICI passed away on April 23, 1943, at the age of 54 years. To many of his friends the news of his death will come as a severe shock. His youthful appearance and active mind gave promise of many more years of productive and fruitful service. His associates, however, were aware of his failing health and were therefore somewhat prepared for the blow when it fell.

Dr. Henrici's Germanic ancestors migrated from Grosskarlsbach to Pittsburgh in 1825, where many of their descendants still reside. Born in Economy, Pa., on March 31, 1889, Dr. Henrici moved with his parents to Pittsburgh when a boy. Here he attended public schools and entered the medical school of the University of Pittsburgh in 1907, where he was graduated at the head of his class four years later. Upon graduation he received the Brinton Award in recognition of outstanding scholarship. Following graduation from the medical school, he served for about a year and a half as pathologist in St. Francis Hospital under the late Dr. Klotz.

In 1913 Dr. Henrici was appointed instructor in bacteriology at the University of Minnesota, where he spent the greater part of his distinguished professional career. He was made a professor of bacteriology in 1925. Following the outbreak of World War I, he enlisted in the Army Medical Corps. He served as captain with his unit in France until after the Armistice.

Dr. Henrici's research interests were largely in the fields of morphology and taxonomy. He soon became a recognized authority in these branches, so much so that he somewhat personalized these fields. In addition to his contributions to scientific journals, he is the author of "Morphologic Variation and the Rate of Growth of Bacteria," "Molds, Yeasts, and Actinomycetes" and "The Biology of Bacteria." He was a member of the Society of American Bacteriologists, of Sigma Xi and of Alpha Omega Alpha. He was associate editor of the *Journal of Bacteriology,* and in 1939 he served as president of the Society of American Bacteriologists. In 1941 he held the Walker Ames Lectureship at the University of Washington.

As a teacher Dr. Henrici had few peers. His clarity in presentation of data was a model of pedagogic technique. Dr. Henrici was loved and admired by his colleagues and idolized by his students. His death will long be mourned by all who knew him.

W. P. LARSON

RECENT DEATHS

FRED HALL KAY, geologist, vice-president in charge of exploration and production for the Standard-Vacuum Oil Company, died on July 9 at the age of fifty-eight years.

DR. EDITH HALL DOHAN, curator of the Mediterranean section of the University of Pennsylvania Museum, author, and member of several expeditions to Crete, died on July 14 at the age of sixty-five years.

SCIENTIFIC EVENTS

RESEARCH IN THE UNITED STATES

Nature makes the following comments on a recent statement made by Sir Ernest Simon before the Parliamentary and Scientific Committee concerning research in the United States:

The research unit of the Bell Telephone Company, for example, has some 5,000–6,000 research workers concentrated on the one problem of telephonic communication. In the United States there seemed to be little need to persuade the business man, hard-headed though he be, of the value of research. He is now so firmly convinced by the results of the last twenty years, in peace and in war, of the necessity of research, that expenditure has risen to an astonishing figure, and, during the great depression, the research budget was the last to be cut. In 1940, according to an official report, industry was maintaining some 2,200 laboratories with a research staff of 70,000, at an annual cost of three hundred million dollars. Sir Ernest wondered what the expenditure is in Great Britain; he doubted whether it was £4,000,000, yet it was to be noted that the United States population was only three times greater than ours. Per head he estimated that the United States was spending five times as much as we spend on university and industrial research. The results were significant. America now leads in hydrocarbon research, the world order being now: United States first, Germany second, Russia third and Great Britain fourth. Yet coal is our only special large-scale natural resource, and success in the difficult post-war period in exporting enough to pay for our essential imports will depend to a substantial extent on the most scientific treatment of our coal in order to get from it the maximum value.

This question of research is, of course, broadly divisible into two parts: research conducted by industrial organizations and research conducted by universities, and Sir Ernest Simon had some equally striking points to make concerning American universities. Their size and number is almost startling. When, during 1937–38, we had about 50,000 university students in Britain, America had a million. Their income was £97,000,000, while ours was just over £6,000,000. American grants from government authorities were ten times, and from private generosity, twenty times as great as ours. In engineering, for example, there were, in the same year, 12,000 graduates from the American schools compared with about 800 in Great Britain. Now none more than ourselves realizes that this comparison either of research or of numbers of universities and students may quite easily be very misleading. There are many factors which need close examination before final and valid conclusions can be drawn. The standards of graduate qualification must be closely examined and more particularly the work done by post-graduate students. The same care is needed when comparisons of arrangements for research are made, for research is a word capable of many interpretations. In saying that, we have no intention of attempting to detract from the vast and expert work of American research organizations and of American universities. By whatever test which may be applied it seems clear, from the points made by Sir Ernest Simon, that America has set and is setting an example which ought, without any avoidable loss of time, to be followed in Britain. The discussion which followed Sir Ernest's statement showed how the problem was appreciated by his listeners and gave indications of where research here should be encouraged and fostered.

VITAMIN D PATENTS

THE following "special" has been sent from San Francisco to *The New York Times* by Lawrence E. Davies:

Patents covering production of vitamin D, reported to have yielded royalties exceeding $7,500,000 to the University of Wisconsin Alumni Research Foundation, have been held invalid by the Federal Circuit Court of Appeals.

The decision was written by Judge William H. Denman, with concurrence by Judge Albert Lee Stephens. Judge William Healy concurred in a separate opinion.

The case was taken to the Circuit Court by Vitamin Technologists, Inc., on appeal from a lower court at Los Angeles which had held the Steenbock patents valid and infringed.

The patents in question covered a process of producing vitamin D, known as a preventive of rickets, by subjecting foods to radiation of ultra-violet rays such as are obtained from the quartz vapor lamp.

"Primarily it is to be noted that the claim applies to all ultra-violet rays," Judge Denman wrote in the opinion. "It is not confined to such rays as are produced by a particular medium, such as the quartz lamp. It includes, of course, the ultra-violet rays of the sun.

"Many years before the application, science had discovered that the sun's rays shining on cut alfalfa hay cured in the field was an antirachitic food for pigs.

"Steenbock himself verified the facts concerning alfalfa by the discovery that when cured out of the sunlight it lacked the antirachitic quality exerted when cured in the field.

"We thus have the inventor proving that it is from the ultra-violet rays of the sun that the alfalfa acquires its vitamin D, that is, by the process claimed by him as patentable.

"If the patent be valid, it is thus seen that the farmer is an infringer when he exposes his cut alfalfa to the ultra-violet rays of the sun long enough to make it antirachitic.

"So also the long previously established practice of the radiation of milk by the mercury vapor lamp would infringe the monopoly of Steenbock's patent because, admittedly, in its customary use it would produce in the milk vitamin D."

The court asserted that Dr. Steenbock's "great contribution" to science and human needs was "his more exact recognition of what had transpired in all these prior practical uses of the ultra-violet rays in producing the then unnamed Vitamin D substances."

It added that the District Court had erred in saying that "nature, unaided by man, does not and can not antirachitically activate foods for medicines."

"The clear vision of such a scientific investigator as Dr. Steenbock well may create vastly higher indebtedness from the world of human beings than owed to the inventors of mechanisms and processes to whom his vision is the inspiration," Judge Denman's opinion continued.

"However, our Congress as yet has provided no system of reward to the pure scientist, while it has to the inventor for his processes and mechanism. Steenbock's valuable scientific certitudes are discoveries, but they are not inventions within the meaning of the term 'invention' as used by the Congress in its patent laws."

Judge Denman explained that Dr. Steenbock had been preceded by "the discovery by Hume and Smith" that rats, made rachitic, had their condition improved when put in a cage with a floor of sawdust into which ultra-violet rays had been radiated from a mercury vapor quartz lamp.

"They thought the radiation of the air the cause of the improvement," the opinion stated. "Steenbock discovered the improvement was caused by the antirachitic quality of the sawdust eaten by the rats. He did not invent a method, but merely discovered what happened in the prior known process."

The court ruled that there could be no infringement because the three patents in the suit were invalid.

THE NATIONAL METAL CONGRESS

PLANS for the twenty-fifth annual National Metal Congress in Chicago during the week of October 18 have been announced by W. H. Eisenman, managing director of the meeting and national secretary of the American Society for Metals.

Final arrangements for a War Conference Display have been completed. All activities will be concentrated in the Palmer House and other Chicago hotels.

The Metal Congress and Conference Displays will center on the increase of war production in the metal industry, to the conservation of metals and to post-war planning. All technical sessions and special daily War Production and Conservation sessions will be streamlined and comprehensive in their contributions to war problems. Mr. Eisenman states that during the past year the metal industry has largely finished its plant expansion job for war and now is confronted with production problems involving shortages of many strategic metals, more efficient use of equipment and continued training of personnel. All these problems will be discussed at the congress.

Four national societies will again cooperate in the congress. In addition to the American Society for Metals, there will be the American Welding Society, the Wire Association and the Iron and Steel and Metals divisions of the American Institute of Mining and Metallurgical Engineers.

War Conference Displays and the sessions of the American Society for Metals will be concentrated in the Palmer House, with the American Welding Society at the Morrison Hotel, the Wire Association at the LaSalle and the American Institute of Mining and Metallurgical Engineers at the Sherman.

The Conference Displays will be placed in the special rooms designed for light displays, which will accommodate light equipment and metal parts. Manufacturers are being urged to use models, moving pictures, photographs and literature to present new developments to the industry.

However, there will be no changes in basic facilities that will enable engineers, executives and production men to get together in one convenient and coordinated meeting place to help solve mutual problems and to bring to the attention of all the developments of the year in the metal industry.

THE NEW DIRECTOR OF THE U. S. GEOLOGICAL SURVEY

WILLIAM EMBRY WRATHER, consulting petroleum geologist, of Dallas, Texas, became director of the Geological Survey of the Department of the Interior at a recent ceremony in the office of Secretary of the Interior Harold L. Ickes. He succeeds Dr. Walter C. Mendenhall, who retired last February after serving in the survey for forty-eight years.

Following the administering of the oath of office by Chief Clerk Floyd E. Dotson, Mr. Wrather received the congratulations of Secretary Ickes and more than a score of bureau and division chiefs and Department of Interior officials. He has been confirmed in the position by the Senate. Previously Mr. Wrather's name had been proposed for nomination by a number of prominent geologists and scientific organizations, including a committee of the National Academy of Sciences especially appointed for this purpose at the request of Secretary Ickes, who wrote:

> I am confident that Mr. Wrather as its new director will add to the outstanding contributions that the Geological Survey has made in its long years of public service. It was my conviction that the selection of a director of this important scientific agency should not have a political consideration. I therefore requested the National Academy of Sciences to propose for the post the names of men who had high administrative ability as well as sound technical and scientific competence. Mr. Wrather was number one on the list provided by that body.

Mr. Wrather was born at Brandenburg, Ky., in 1883. He received his bachelor's degree at the University of Chicago in 1907 and studied at the Graduate School of that institution for two additional years. He was instructor in geology at the University of Chicago in 1922; the University of Texas in 1927; Yale University in 1930; Northwestern University in 1931, and the Southern Methodist University in 1935.

Mr. Wrather represented the National Academy of Sciences and the National Research Council at the International Congress at Madrid in 1926. He attended the National Geological Congress in South Africa in 1929. He was a member of the Organizational Committee of the Sixteenth International Geological Congress in Washington in 1933 and was a delegate to the Seventeenth International Geological Congress at Moscow, Russia, in 1937. For notable work in geology, he was awarded the alumni medal at the fiftieth anniversary of the University of Chicago.

The new director of the Geological Survey is a fellow of the Geological Society of America, in which he has held several offices; a member of the American Association for the Advancement of Science, of which he is a member of the executive committee; a former president of the American Association of Petroleum Geologists; a former president of the Society of Economic Geologists; a former president of the Texas Geological Society, and a member of the American Institute of Mining and Metallurgical Engineers, of which he was chairman of the Petroleum Division in 1933.

Mr. Wrather's professional work has been largely in the field of petroleum geology, but he is recognized as one having wide understanding and appreciation of the entire field of geology. He formerly served as associate chief of the Metals and Minerals Division of the Board of Economic Warfare.

SCIENTIFIC NOTES AND NEWS

DR. HARLOW SHAPLEY, director of Harvard College Observatory; Dr. P. W. Bridgman, Hollis professor of mathematics and natural philosophy, Harvard University, and Dr. L. C. Graton, professor of mining geology, have been elected corresponding members of the Mexican National Academy of Sciences.

THE William Osler Medal of the American Association of the History of Medicine has been awarded to George Edward Murphy, of the School of Medicine of the University of Pennsylvania, in recognition of his essay entitled "The Evolution of Our Knowledge of Rheumatic Fever." The essay will be published in the *Bulletin of the History of Medicine*.

THE American Institute of Electrical Engineers on the occasion of the twenty-fifth anniversary of his election as an officer presented a scroll to Walter Irvine Slichter, professor of electrical engineering at Columbia University. He became an associate of the institute in 1900, member in 1903 and fellow in 1912. Sincere appreciation is expressed of his long-continued interest and his uniquely devoted and valuable services in the development of institute activities as director, 1918–22; vice-president, 1922–24; national treasurer since 1930, and chairman and member of many institute committees, 1910–1943. Presentation of the scroll was made by Professor Comfort A. Adams, president of the institute.

THE Melchett Medal for 1943 of the British Institute of Fuel has been awarded to Dr. E. S. Grumell, head of the coal research laboratories of the Imperial Chemical Industries, Ltd. This medal is being presented to Dr. Grumell in recognition of "outstanding work tending to the economical use of fuel which he has done over a long period."

PROFESSOR ALBERT EINSTEIN has joined the United States Navy Ordnance Bureau as a "staff member extraordinary" for research work on the phenomena governing explosives. He is working on a part-time basis for the Navy at the Institute for Advanced Study at Princeton.

A UNITED PRESS dispatch from Moscow to *The New York Times* states that the USSR on July 8 awarded the $30,000 Joseph Stalin Prize and the Order of Lenin for the invention of a simple turbo-generator to Professor Leonid K. Ramzin, the Russian electrical engineer. Under a decree issued by the Kremlin, the turbo-generator will bear the inventor's name.

THE College of Physicians of Philadelphia awarded the Alvarenga Prize on July 14 to Dr. Ernest Carroll Faust, professor of medical parasitology and acting head of the department of tropical medicine, Tulane University, for his "outstanding contributions to our knowledge of parasitology and tropical medicine." This prize was established by the will of Pedro Francisco Da Costa Alvarenga, of Lisbon, Portugal, an associate fellow of the College of Physicians, "to be awarded annually by the College of Physicians on each anniversary of the death of the testator, July 14, 1883, to the author of the best work in any branch of medicine which may be deemed worthy of the prize."

ST. OLAF COLLEGE conferred on May 30 the honorary degree of doctor of laws on Dr. Donald C. Balfour, head of the Mayo Foundation, Rochester, Minn., and the honorary degree of doctor of science on Dr. Adolph M. Hanson, Faribault, Minn., in recognition of work on the isolation of the active principles of various hormones.

DR. EDWARD B. STEPHENSON, principal physicist of the Naval Research Laboratory, Washington, D. C., was awarded the honorary degree of doctor of science at the commencement exercises of Knox College.

The Lancet reports that Sir Henry Tidy, president of the Royal Society of Medicine, London, has sent the following greeting to Professor George Mityerov, the People's Commissar for Public Health of the USSR: "On behalf of the 6,000 fellows of the Royal Society of Medicine, which has concerned itself with the science and culture of medicine since the year of its foundation in 1805, and which has actively concerned itself with matters regarding public health, I have the honor to congratulate the People's Commissariat of Public Health on the twenty-fifth anniversary of its foundation and to wish it all prosperity and ever-growing success. May the great work which it has achieved in raising the standard of public health in Russia during the last twenty-five years be amplified and improved at an ever-increasing rate both now and in the time that is to come when the defeat of the Axis, due to the joint efforts of the Allied Nations, will set free all our energies for the betterment of the lot of humanity."

DR. W. K. FISHER, since 1917 director of the Hopkins Marine Station of Stanford University at Pacific Grove, Calif., will retire on August 31 with the title professor of biology, emeritus. He will be succeeded by Dr. Lawrence Rogers Blinks. Dr. Fisher will continue research at the station as associate in zoology of the U. S. National Museum.

AT the School of Medicine of the University of Minnesota, Dr. J. C. McKinley, head of the department of medicine and director of the division of nervous and mental diseases, has been named head of the newly established department of neuropsychiatry, which includes the divisions of adult psychiatry and child psychiatry. Dr. Cecil J. Watson has been named head of the department of medicine and director of the division of internal medicine, and Dr. Raymond N. Bieter, professor of pharmacology, has been appointed head of the department of pharmacology to succeed the late Dr. Arthur D. Hirschfelder.

DR. GEORGE HUGH BOYD, professor of zoology and chairman of the division of biological science of the University of Georgia, has been named dean of the Graduate School. He succeeds as dean Dr. R. P. Stephens, head of the department of mathematics.

DR. T. DALE STEWART, curator and administrative head of the Division of Physical Anthropology in the U. S. National Museum, has been appointed visiting professor in anatomy at the Washington University School of Medicine for six months beginning on July 1.

DR. WENDELL H. TAYLOR, assistant professor of chemistry at Princeton University, has been appointed head of the Department of Science at Lawrenceville School, New Jersey.

THE trustees of the Lady Tata Memorial Fund announce that on the recommendation of the Scientific Advisory Committee they have agreed, if circumstances permit, to make awards for research in blood diseases, with special reference to leukemia, in

the academic year beginning on October 1. Among those mentioned as recipients of grants is Dr. J. Furth, of the Cornell University Medical College, New York.

DR. W. G. OGG, director of the Macaulay Institute for Soil Research, Aberdeen, Scotland, has been appointed director of the Rothamsted Experimental Station to succeed Sir John Russell, who will retire in September.

AN Associated Press dispatch reports that Surgeon General Thomas Parran has announced the appointment of Dr. Raymond A. Vonderlehr as director of district No. 6 of the United States Public Health Service covering Puerto Rico and the Virgin Islands. Dr. Vonderlehr recently completed eight years' duty as assistant surgeon general in charge of the division of venereal diseases.

DR. LEVERETT D. BRISTOL, of Montclair, N. J., health director of the American Telegraph and Telephone Company, has been offered by the New Jersey State Board of Health the position of state health director, to succeed Dr. J. Lynn Mahaffey, of Haddonfield, who has resigned.

CAPTAIN JOSEPH N. LECONTE, formerly with the Chemical Warfare Service, Fourth Service Command, Atlanta, has been promoted from the rank of first lieutenant to become chief of Chemical Section Inspection, Chemical Warfare Service, Washington, D. C.

DR. LOGAN J. BENNETT, biologist of the U. S. Fish and Wildlife Service, has been commissioned in the Naval U. S. Reserve as a Lieutenant (j.g.). He reported for active duty on July 15. Dr. Bennett has been with the Fish and Wildlife Service for the past eight years. From 1938 to the time of his enlistment in the Navy, he has been leader of the Pennsylvania Cooperative Wildlife Research Unit with headquarters at the Pennsylvania State College.

DONALD MCLAUGHLIN resigned on July 1 as dean of the College of Engineering and chairman of the department of mining engineering of the University of California at Berkeley, to accept the position of vice-president and director of the Cerro de Pasco Copper Corporation, New York, N. Y. He is continuing as consulting geologist and director of the Homestake Mining Company and related companies.

DR. FLOYD S. MARKHAM, associate professor of bacteriology at the Ohio State University, has left for North Africa to take charge of laboratories for the Typhus Commission of the Rockefeller Foundation.

THE Lord President of the Council has promoted Dr. B. A. Southgate to be acting director of water pollution research in the British Department of Scientific and Industrial Research. He succeeds Dr. A. Parker, who has been made director of fuel research.

THE Frederick Price Lecture of the Royal College of Physicians of Edinburgh was delivered on July 2 by Sir Henry Dale, president of the Royal Society. The title of the lecture was "A Prospect in Therapeutics."

PROFESSOR EDWARD KASNER, of Columbia University, recently addressed the Forum of *Scripta Mathematica* in New York on "Circles, Spheres and Geology."

BY the will of Mrs. Harriette M. Arnold, of New York City, her residuary estate, amounting to $17,683,533, is distributed equally among St. Luke's Hospital, which also was bequeathed $50,000; the Metropolitan Museum of Art, New York Public Library, Trinity Church, Harvard College, Yale University and Princeton University. Other bequests include $100,000 each to Columbia University, Barnard College, Bard College at Annandale, N. Y., the General Theological Seminary of the Protestant Episcopal Church, New York Hospital and St. Mary's Hospital for Children, Inc. Among institutions receiving bequests of $50,000 are the University of the South, Sewanee, Tenn.; the New York Medical College Flower and Fifth Avenue Hospitals; Presbyterian Hospital in the City of New York, the Roosevelt Hospital and the Lying-in-Hospital. Bequests of $25,000 are made to Manhattan Eye, Ear and Throat Hospital, to Vassar College and to Smith College.

DISCUSSION

CIRQUES, HANGING VALLEYS AND HIGH-LEVEL BENCHES IN GLACIER NATIONAL PARK[1]

As shown on the topographic map of Glacier National Park there are, back in the mountains, numerous high-level cirques and relatively large benches on some of which are now small glaciers. Below these are nearly vertical cliffs 1,000 to 2,000 feet or more in height above the adjacent parts of the main valley

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior.

floors. It has generally been considered that these features hang so high above the valley bottoms because the large Pleistocene trunk glaciers wore down their valley bottoms much faster than did the small tributary glaciers. It appears, however, that this is not the full explanation.

Bordering the east front of the mountains there are, 1,000 to 2,500 feet or more above the intervening glaciated valley bottoms, remnants of old high-level piedmont benches which, near the mountains, are capped with much-weathered glacial drift, some of which is cemented to hard tillite. At corresponding levels farther out, similar bench remnants are capped with coarse, non-glacial stream gravel. When this ancient stream gravel and this old, weathered, early Pleistocene till were deposited the mountain gorges and the outer valleys were not so deep as now by 1,000 to 2,000 feet or more. If normal stream gradients, corresponding to the smooth, sloping bench tops, be projected back up the gorges to their heads, it is seen that many of the cirques, hanging side valleys and bench remnants are at heights corresponding in general with these projected old trunk valley bottoms. This relationship suggests that the tributary, V-shaped gulches and headwater hoppers which were later reshaped and enlarged by glaciation were genetically related to the positions of the late Tertiary or early Pleistocene valley bottoms. Down these valleys and out onto the smooth gravelly piedmont, the great early Pleistocene glaciers advanced, deposited their load and melted back up the valleys.

As a result of renewed regional uplift the streams then trenched the U-shaped early Pleistocene valley bottoms and cut V-shaped inner gorges to considerable depths before the last, or Wisconsin, stage of glaciation came on. Just how many interglacial stages there were in the region of Glacier Park is not definitely known; there were probably at least two. Each time the glaciers readvanced they deepened the valleys somewhat and they broadened the valley bottoms very notably by plucking and scouring away the lower side slopes. The broadening of the inner gorges by the readvancing glaciers was probably facilitated by the narrowness of the projecting craggy spurs between the numerous tributary gulches.

Such interglacial stream erosion both east and west of the Continental Divide undoubtedly accounts for much, if not most, of the Pleistocene valley deepening. The shapes of the inner gorges, the projecting spurs between the tributary gulches and the thin bedding and fractured condition of much of the sedimentary rock composing the mountains particularly favored the work of the glaciers in plucking masses of rock and wearing away and oversteepening of the lower side slopes. It seems to have been such a combination of alternating stream and glacial erosion which accounts for the lateral benches, hanging cirques and short tributary glaciated valleys being left so high above the bottoms of the trunk valleys down which the last of the Pleistocene glaciers advanced. Since the last of these great glaciers disappeared, the streams have accomplished relatively little erosion. There has been some, but not a great deal of, enlarging of the cirques by the small glaciers of Recent time.

WM. C. ALDEN

GRAZING VERSUS MAPLE SYRUP

THREE years ago at the request of A. C. Norris, an alumnus of Oberlin College, Miss Elaine Hoff, a graduate student in the department of botany at Oberlin College, undertook a cooperative study of maple groves in Lorain County, Ohio. Her analyses indicated that the quality of these groves was suffering from the fact that they were being used as pastures. One grower, R. E. Campbell, then fenced a grove containing 500 trees and excluded cattle, sheep and horses from it. An additional leased area gives a total of 1,425 trees covering about 225 acres which were protected or very slightly pastured. In the intervening two years, wildlife and tree seedlings have increased, and there have been some indications of increased sugar production, but it was difficult to obtain precise yield data. During the season just ended, however, the 1,425 trees which were protected from grazing produced an average of nearly 1 quart of syrup per tree against approximately 1 pint per tree from other groves in the neighborhood which have remained pastured. Furthermore, the unpastured area produced a yield of 40 barrels of sap after flow had ceased in the pastured woodlands. Previous to protection, the sap flow was no better than that of other pastured groves in the area. The 1943 yield represents an increase in gross income of $570 for the unpastured area. The area, rented for pasture, would have brought in less than half this amount.

While this test may not be conclusive, it is certainly significant, particularly in view of the fact that one of the most serious sources of economic waste in the North Central States is the grazing of woodlands and consequent destruction of undergrowth, including seedlings. Data accumulated by the Ohio Experiment Station indicate that an ungrazed, properly managed woodland can be quite as profitable as any acreage on the average farm. Other data indicate that enlightened practices of pasture management will yield nutrient values sufficient to reduce the area of feed crops and make unnecessary the use of woodlands for supplementary grazing.

Since writing the foregoing, I have had the follow-

ing pertinent word from Dean L. E. Call, of the School of Agriculture of Kansas State College, in which he acknowledged my "letter of April 13, reporting on the yield of maple syrup from unpastured and pastured maple groves. The contrast is striking and is in complete conformity with the results that my brother has obtained where he has been protecting his grove from cattle for the last seven or eight years. Not only has the yield of sugar increased in his grove, but the condition of the trees is much better than it was at the time he started the practice. I spent a few days on his farm last August (the farm where I was born and raised) and I had never seen the maples in more thrifty condition than they were last summer."

PAUL B. SEARS

OBERLIN COLLEGE

THE MERITS OF ABSTRACTING JOURNALS

AT the present time there are circumstances that give a special importance to abstracting journals. Part of the world's scientific literature, including some of the most used journals, is no longer accessible. Reprints of the articles are not distributed, and it has been difficult or impossible to find out what the publications are. As time has passed, since the beginning of the war, some sources have been found for certain otherwise unobtainable publications; but the limitations that exist preclude direct use of this by the ordinary scholar who is not fortunately situated.

In English and American serial publications titles and abstracts of some of this literature are appearing. They are scattered, often, in specialized bibliographic journals, and the coverage is necessarily incomplete and sporadic. Bibliographic agencies are in the best position to learn of and to make use of sources of the publications, if they are available anywhere; and by publication of titles and abstracts those agencies can provide information that could be obtained otherwise only with much difficulty and expense.

Biological Abstracts is the only comprehensive abstracting journal for biologists in English; its significance to biologists can not be too much emphasized. Organization of the results of contemporary studies into compact, easily consulted form is one of the most important services that can be given to students and investigators; and an extensive index like that which is prepared for *Biological Abstracts* is a very valuable guide to this organization. In doing justice to the literature of the world on a subject, the specialized abstracting journals have an advantage in that their energies and facilities can more easily be adequate to cope with their undertaking. The main difficulty that hampers the work of such comprehensive journals as *Biological Abstracts* is that so much more in energies and facilities is required that it is difficult to provide. The accomplishment realized in that journal, however, in the relatively few years it has been published, shows that the energy and interest are abundantly present in its staff and in the large number of biologists who collaborate. There is clear understanding, too, of the problems that need to be solved, and elimination of imperfections awaits only the provision of increased support.

The interests of all who make use of the results of research in science will be furthered if the support of established abstracting journals is made sufficient not only to continue and improve the permanent values of organization of reports, but also to carry on to the fullest extent possible the dissemination of information concerning current scientific research in nations with which free communication is at present absent.

HAROLD KIRBY

DEPARTMENT OF ZOOLOGY,
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BERKELEY

QUOTATIONS

SCIENCE AND SOCIETY

IN war Britain has learned that to neglect science is to court disaster. Before the war scientific research was far too commonly regarded as an activity remote from life, the practitioners of which could not be expected to make important contributions to solving the country's manifold industrial, social and human problems. Too little public or private money was spent on research. Expenditure on agricultural research, for instance, amounted to only a fraction of 1 per cent. of the value of the total output from the land, although a more generous endowment would have repaid itself economically many times over. Or, to take another example, research into the physical and psychological requirements of health in industry was hampered by lack of public interest and dearth of funds. Even more serious was the failure in far too many spheres of life to turn to practical ends the new knowledge which men of science were accumulating.

The basic facts about vitamins and food values were already well established when the Medical Research Council published its important report on "Vitamins: A Survey of Present Knowledge" in 1932. But very little was done, until the outbreak of war, to educate the public to a better appreciation of food values or to develop a food policy designed to counter

the widespread malnutrition which was known to exist. Again, in a different field, there were undoubtedly unnecessary delays in the practical utilization of new inventions. Pre-war official investigations of the history of a number of the most important American inventions showed that from thirty-three to fifty years usually elapsed from the time of the first working model to the time when the invention had come into general use. There is little reason to doubt that the experience of Britain has been similar. It is understandable therefore that many scientists and technicians before the war increasingly came to feel that they should be "on top" rather than "on tap," since the "tap" was only too often not fully turned on.

Britain at war can not afford to dispense with science. It is at last safe to say that science has been granted a great measure of the recognition and facilities it requires. Great improvements in productive techniques, in the quality of war materials, advances in the design of aircraft, tanks and shipping, the development of radio-technology and many other devices, all testify to this. Thanks to the U-boat and to Lord Woolton and his scientific advisers, the public has taken tremendous steps forward in its nutritional knowledge. It is possible to believe that there is less malnutrition in Britain to-day than before the war. These are only some of the respects in which war-time necessity has compelled a better utilization of scientific and technical capacity. As a letter published on this page this morning points out, the neglect of the scientist and technician which was tolerated before the war will be as intolerable in the future as it would be now. The nation needs more science, in peace as in war, and must be prepared to pay for it. While science can not offer a utopian "age of plenty," Sir Robert Pickard, Professor Findlay and Sir Lawrence Bragg rightly insist that, in order to maintain and improve Britain's future standards of health and well-being, "scientific and technological research will be required on a scale not yet envisaged." If this fact is squarely faced and acted upon, and provided that experts are freely and fully consulted, few will disagree with our correspondents' judgment that a democratic community can not allow to the scientist, as scientist, a "position of exceptional authority in deciding the policies of governments." It is when the expert is ignored or frustrated that he becomes a "technocrat."—*The Times*, London.

SCIENTIFIC BOOKS

THE WORLD OF THE PHYSICIST

From Copernicus to Einstein. By HANS REICHENBACH. Translated by RALPH B. WINN. 123 pp. New York: Philosophical Library. 1942.

A PHYSICIST would infer from the title of this book that it would give a survey of all the great discoveries, all the great contributions leading us to our present knowledge of the physical universe. For in the time of Copernicus the world of the physicist was without form and void and darkness covered the deep mysteries of nature. During these 400 years light has entered. How the universe has grown as light supplied by a host of workers has at length allowed us to see vast bodies at distances "farther than ever comet flared or vagrant stardust swirled" or to penetrate into the inner recesses of particles in which masses and distances are measured in micro, micro, micro units. But the 123 pages of this book would hardly be adequate for the unfolding of the story. Its purpose is "to serve as an introduction to the great problems of space, time and motion. More definitely, it is concerned with the development (and glorification) of the theory of relativity. Its methods are very simple. No mathematical formulae or operations, no computations of any kind are introduced. It starts with the revolutionary view introduced by Copernicus—the earth does not stand still. The conservatives fought against his view. It belied the testimony of our senses. "So too do the revolutionary views introduced by Einstein."

From the consideration of motion and gravitation the book proceeds to the problems of light. What is light? Is there an ether? What did the Michelson and Morley experiment prove? According to the author it proved that there is no ether. And Einstein seized this result, "one of the greatest experimental precision." Thus "Einstein's theory of relativity, the most magnificent achievement of modern physics, was suggested by the closest adhesion to experimental facts" (p. 51). Unfortunately, however, it would appear that the author has never seen the interference fringes in a good interferometer and he has an extremely hazy view of the phenomenon of interference, for in explaining the Michelson and Morley experiment he states that "the belated arrival" of one of the beams "could be proved by the appearance of shadow bands." "Yet the surprising result was that no shadow bands appeared at all: there was no retardation of the ray" (p. 55). Shades of Michelson, Morley, D. C. Miller! The fact of course is that the interference fringes (shadow bands) were marvelously clear. What was looked for was a side shift of the fringes as the instrument was rotated so that the East-West arm became the N-S and *vice versa*. In the Michelson and Morley experiment no appre-

ciable shift was seen, in the Miller case a partial shift (cause unknown) was detected.

The decrease in frequency, the increase in wavelength, of a spectral line sent out from an atom in a very strong gravitational field as compared with the radiation in a weak field is set forth, but again the author's knowledge of physics is greatly at fault. According to him "the number of vibrations of the light emitted by a *circulating electron* is a measure of the number of revolutions of the electron about the nucleus." That point of view, briefly held, was exploded thirty years ago. The author believes that the confirmation of this result of the relativity theory —the red shift of spectral lines due to strong gravitational fields—depends on the completion of the "Einstein tower" in Potsdam, "a structure combining to perfection every astronomical and physical contrivance," designed by E. Freundlich (who according to the translator was forced to leave Germany in 1933), who was to measure with high accuracy the dark lines of the solar spectrum. But the shift for radiations coming from dense stars has been found. It is several times greater than the computed solar shift and is in accord with the theory.

The book is intended to acquaint philosophers with some of the new aspects of matter and motion. But the author does not feel that it is necessary, perhaps not even advisable, to point out that some of these new properties, such as the increase of mass on account of motion, have an experimental basis entirely apart from the theory of relativity. It may be that the author desires to avoid, for himself and his probable readers, the difficulties involved in the elucidation of these experiments.

GORDON FERRIE HULL

RADIOLOGY IN INDUSTRY

Industrial Radiology. By ANCEL ST. JOHN and HERBERT R. ISENBURGER. Second edition. New York: John Wiley and Sons, Inc. 1942.

THE first edition of this book, entitled "Industrial Radiography," was published in 1934. The chief subjects of the first edition and of the present revised edition are the examinations by means of x-rays and gamma-rays of castings, forgings, welded joints, packaged materials, assemblies such as vacuum tubes and other industrial products. The authors are pioneers in this field of investigation. During the last five years, the use of the methods which they discuss has increased tremendously. Thus, they have an admirable background for describing the radiographic and fluoroscopic methods which are used for examining a great variety of the products of industry.

The new second edition contains in slightly revised form the material of the first edition. The discussions of gamma-ray radiography and fluoroscopy have been expanded in the new book.

The most important new material in the second edition is the expansion of the list of references in the field of industrial radiography. In the first edition, the bibliography at the end of the book lists 426 books and articles in technical journals. In the new edition, there are 1,314 items listed in the bibliography; some of these are as recent as October, 1942. The index is very usefully arranged. After each item of the index, page numbers appear, as in the conventional index; in addition, there are numbers in italics and these refer to the numbered references in the bibliography. Thus, if the book is used as a reference work, an item in the index will refer the reader not only to the material in the book on this particular subject, but also to the work of one or more writers who have presented their work in the technical literature.

No material is included in this book on the use of x-ray spectroscopy in industry. One might be led to believe that such material would form a part of "industrial radiology." Apparently, the use of x-ray spectroscopy in industry and the use of x-rays and gamma-rays for making fluoroscopic or radiographic examinations are two distinct fields; the authors of this book confine their attention to radiography and fluoroscopy, except for a brief note on the diffraction of x-rays in Chapter IV.

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ENZYMES

Chemistry and Methods of Enzymes. By JAMES B. SUMNER and G. FRED SOMERS. 365 pp. New York: Academic Press, Inc. 1943.

AN author of a book on enzymes, unless he writes an all-inclusive one such as Oppenheimer's Handbuch, faces the same problem as an anthologist. His choice and emphasis will follow his personal predilection or some definite plan. The authors of this book on enzymes appear to have followed the former method.

The enzymes are classified in the usual way into esterases, proteases, oxidases, etc. With the exception of urease, which is discussed as a possible important factor in the nitrogen cycle, no attempt is made to assess the functions of the enzymes in the cell. Perhaps as a consequence of this, the amount of space allotted to an enzyme is not commensurate with its known importance. For instance, under the esterases the cholinesterase is discussed in one and a half pages and no description of the methods of isolation is given, whereas chlorophyllase, the function of which is still unknown, is allotted more than two pages which include a detailed description of its preparation. Under the proteases, the methods for the crystallization of

trypsin, pepsin, and various peptidases are described in detail almost as great as that found in Northrup's book on Crystalline Enzymes, but the methods for the crystallization of papain and ficin are not included.

The discussion of each enzyme begins with a short historical note followed by a list of organs or organisms where the enzyme has been found. With the exception of urease no data are given to indicate the relative concentration of the enzyme in the cells where it occurs. The action and specificity are then discussed and excellent formulae and equations are presented. This is usually followed by a description of the preparation and purification of the enzyme and a very useful outline of the methods for the estimation of its activity. The compounds which inhibit the enzyme are listed but the value of this is limited by the fact that neither the concentration of inhibitor, the conditions under which it acts nor the references are usually given. Moreover, the lists are generally far from complete. Eserine is the only inhibitor mentioned for the cholinesterase and 3 M urea the only one for the monamine oxidase.

The book begins with a simple and clear account of the general characteristics and properties of enzymes and ends with a chapter on carbohydrate metabolism and the Szent-Györgyi and Krebs cycles. This chapter includes the facts and theories made familiar by the numerous reviews that have recently appeared on the subject. The book on the whole is clearly and tersely written, well printed, and has only a small number of misprints. Enzyme chemists should find it useful particularly because of the formulae and methods of estimation which are given. Since, as the title implies, chemistry and methods are the main concern of the authors, the book may be considered to have achieved its purpose.

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WILDLIFE REFUGES

Wildlife Refuges. By IRA N. GABRIELSON. New York: The Macmillan Company. 257 pp. 32 plates. 17 figs. 1943. $4.00.

FOR so many years it has been the fate of one who wrote of the wild life of the country to approach the subject with a feeling of despair, that it is quite a relief to find a book which is openly and frankly optimistic, a book which speaks of attainments rather than of defeats and losses. Instead of recording increasing additions to lost causes it contains references to 17,643,915 acres added to the national wildlife refuges and many other acres under private and public ownership. It is indeed heartening to read that "All together they are approaching adequacy," especially as it appears under the name of the director of the Fish and Wildlife Service. Here one may read the history of the movement from the early action by the California legislation in 1870, through a succession of similar events in a series of actions until finally in 1939 332,438 acres were added by the Resettlement Administration. These are all national efforts, to which must be added many more state refuges and numerous private grounds.

The book covers so much ground that it is impossible to note every phase of the treatment, but possibly a brief review of one topic, the Okefenokee swamp area, will serve to present the treatment. It is noted here that this area is impossible to classify, having inhabitants that would permit it to be designated as a migratory wild-fowl area, a big game refuge or a general wildlife refuge. The condition of the forest is much regretted, but it is pointed out that before many years have passed, it will be back in good form again, because of what still remains and because of the rapid growth of vegetation. The prairies are described and also the peculiar methods of travel. Only when he comes to a description of the animal life in the morning and evening of the day does the author's statement that "Okefenokee is marvelous" find justification. A brief general description of the swamp, in which the occurrence of the fabulous "sink holes" is vigorously denied, is followed by an account of the fishing, which is described as "locally famous." It is believed that this is a permanent condition, although the habit of going dry and burning is recognized as a handicap. Finally the author takes up the subject of the future of the swamp, pointing out the desire to restore it to its former state, but also indicating that some animal form such as the panther and ivory-billed woodpecker seem to be entirely absent now. Altogether the account ends most hopefully. Each topic in the book is taken up in a similar way, and the final picture is one of great hope and expectation.

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SPECIAL ARTICLES

INTERFERENCE OF INACTIVE VIRUS WITH THE PROPAGATION OF VIRUS OF INFLUENZA

NOT much is known as to the optimal conditions for the propagation of the influenza A and B virus in the allantoic cavity of the chick embryo. In an attempt to gain this information it was found that the active virus as shown by titration in mice may reach maximal titer (50 per cent. mortality end point) in the allantoic fluid as early as 12 to 18 hours after

infection, depending on the concentration of the inoculum. After attaining maximal concentration the amount of active virus decreased more or less rapidly with further incubation of the embryos until after 3 or 4 days frequently less than 1 per cent. of the highest titer was left.

In contrast to the active virus as titered in mice the red cell agglutinative reaction became positive in the allantoic fluid later and after reaching maximal strength the agglutinating titer remained more or less constant usually for at least 48 to 96 hours of incubation.

Using fluids collected at the height of active virus titer, subcultures ultimately reached equally high red cell agglutinating titers, regardless of whether undiluted or 10,000 to 100,000-fold diluted virus preparations had been used as inocula. However, when allantoic fluids were passed which had been harvested at a time when the active virus titer had decreased markedly, the growth of virus from a concentrated inoculum (0.5 ml of undiluted or 10-fold diluted fluid) was much less than the growth of the virus from an inoculum diluted 1,000-fold or more (Table 1). This

TABLE 1

RELATION BETWEEN THE CONCENTRATION OF THE INOCULUM AND THE PROPAGATION OF THE VIRUS

Inoculum* 0.5 ml diluted	Time of harvest (hours)	Titration in mice LD_{50} per ml† log	Agglutination of chick red cells units per ml
1 : 10	24	3.3	8
	48	2.0	48
	72	n.t.	48
	96	1.3	16
1 : 100	24	3.6	0
	48	4.3	224
	72	n.t.	192
	96	2.1	160
1 : 1000	24	2.0	0
	48	5.8	512
	72	4.5	640
	96	4.0	384

* Lee strain of influenza B.
† 50 per cent. mortality doses per ml.
n.t. = not tested.

paradoxical behavior had previously caused difficulties in the passage of some influenzal strains and even led to their occasional loss.

It appeared possible that inactive virus accumulating with prolonged incubation could interfere on subculture with the propagation of the active virus in the allantoic sac. When active virus in optimal dilution (homologous or heterologous strains) was added to such "inhibiting" fluids and the mixture passed to chick embryos, the resulting formation of the red cell agglutinating agent was never higher than that in other eggs inoculated with a mixture of "inhibiting" fluid and saline solution. The use of normal allantoic fluid and normal chorio-allantoic membrane obtained from embryos of the same age as the "inhibiting" fluid did not prevent the normal propagation of the virus.

In an effort to demonstrate the "inhibiting" factor more clearly, attempts were made to inactivate the viable virus in fluids harvested 24 or 96 hours after inoculation. Heating of the fluids to 56° C. for 30 minutes or even 1 hour, or ultraviolet irradiation[1] under continuous mechanical agitation for 30 to 60 minutes usually inactivated enough of the virus to render them innocuous for mice, but sufficient concentrations of the active agent were left to initiate some multiplication when injected into the allantoic cavity of chick embryos. Although inactivation was incomplete, the following inhibition experiments have given clear-cut results.

Active virus was injected in optimal concentration into embryonated eggs either simultaneously with, or 3 hours following, the administration of the partially inactivated fluids described above, and the propagation of the virus was measured by titration of the allantoic fluids harvested 48 hours later either by inoculation of mice or by red cell agglutination. In each case the titers were reduced to those of the control fluids, prepared by injecting "inhibiting" fluid and saline solution. The experiment summarized in Table 2 shows that no red cell agglutination was noted after 48 hours and further incubation did not alter the result. Titration of the allantoic fluid in mice, on the other hand, revealed the presence of some active virus, which, however, amounted to only a fraction of 1 per cent. of the amount of virus found in the allantoic fluids collected from eggs inoculated with active

TABLE 2

INTERFERENCE OF PARTIALLY INACTIVATED VIRUS WITH THE PROPAGATION OF THE ACTIVE AGENT

First injection 0.5 ml	Second injection 3 hours later 0.5 ml	Results after 48 hours of incubation: Titration in mice LD_{50} per ml log	Red cell agglutinating agent units per ml	Complement fixation antigen units per ml
Irradiated virus* harvested 24 hours after inoculation (undiluted)	saline	4.0	0	0
	virus* 1 : 1000	4.3	0	0
Irradiated virus* harvested 96 hours after inoculation (undiluted)	saline	2.8	0	10†
	virus 1 : 1000	3.3	0	10†
Normal allantoic fluid	virus 1 : 1000	6.8	768	160

* WS strain of influenza A, allantoic fluid.
† Corresponding to originally injected antigen, no formation of antigen.

[1] A Hanovia Examalite quartz lamp was used.

virus following administration of normal allantoic fluid.

Similar interference experiments conducted in mice by the intranasal injection of partially inactivated virus preparations, followed 5 hours later by the active agent, have given results indicating that the same phenomenon may be demonstrated in this species. Protection against as much as 250 50-per-cent.-mortality doses was noted.

Interference of one virus with another has been observed repeatedly. The viruses may be quite unrelated or very closely related, as is the case with neurotropic and non-neurotropic strains of influenza Type A virus.[2] Interference of inactivated bacteriophage with the active agent of the same strain has been observed recently[3] and the present results extend these observations to the influenza viruses. It seems very likely from the data presented that virus having been inactivated during the process of cultivation may cause such interference phenomena and account for the difficulties encountered in the propagation of some strains of influenza virus. A more extensive report will be published elsewhere.

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THE EFFECT OF CASTRATION AND TESTOSTERONE PROPIONATE ON d-AMINO ACID OXIDASE ACTIVITY IN THE MOUSE[1]

IN recent reports from this laboratory we have indicated the effect of castration and testosterone propionate on the activity of three hydrolytic enzymes.[2, 3] We now wish to report findings with respect to an oxidative enzyme, d-amino acid oxidase.

The mice were of an inbred stock, Buffalo-Marsh strain.[4] Castration and implantation of the testosterone propionate[5] pellets were performed when the mice were 18 ± gms body weight. The enzyme activity was determined by a modification of Elvehjem's method. The pyruvic acid formed in the presence of arsenite was determined by the 2,4 dinitrophenylhydrazone method.

The results in Table 1 demonstrate that the mouse kidney loses part of its ability to oxidatively deaminate d-alanine as a result of castration. The administration of testosterone propionate not only restores this property but increases it above normal. These data provide further evidence for our program to elucidate the nature and purpose of the protein anabolic properties of certain steroids originally observed in this laboratory in castrate dogs.[6]

TABLE 1

THE EFFECT OF CASTRATION AND TESTOSTERONE PROPIONATE ON THE d-AMINO ACID OXIDASE ACTIVITY OF MOUSE KIDNEY

Treatment*	No.	Weight of kidneys gms	Pyruvic acid formed			
			Total		Per gram	
			micromoles	Per cent.	micromoles	Per cent.
Castrate ..	6	0.259	20.1	−70	75	−54
Normal ...	5	0.402	65.5	..	164	..
Cast. and T. P.	3	0.545	108.0	+64	198	+21
Normal and L. P.	3	0.537	102.0	+55	190	+16

* Body weight at castration 18 ± gms. Treatment for 130 ± days.

The substrates incubated with mouse liver brei in no instance showed the presence of pyruvate. Either the mouse liver possesses no d-amino acid oxidase or it has a different mechanism than the rat for metabolizing pyruvate. We have been able consistently to find pyruvate in good amounts in substrates incubated with rat liver brei according to exactly the same procedure used for the mouse experiments. This difference in enzyme activity between the two species is not too surprising, for we have noted marked differences in the arginase and phosphatase activities in these same species.

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DIFFERENTIAL INHIBITION BETWEEN NORMAL AND TUMOR (CROWN GALL) TISSUE IN BEET ROOTS

A DISTINCT difference has been found by the authors in the action of resorcinol and of cyanide upon the rate of oxygen uptake in the tissues of normal beets and of beet root tumors induced by inoculation with *Phytomonas tumefaciens*.

With normal beet tissue an inhibition of 12 to 14 per cent. is obtained with 0.0166M resorcinol, whereas in tumor tissue this amounts to 20 to 23 per cent.

[2] C. H. Andrewes, *Brit. Jour. Exp. Path.*, 23, 214, 1942.
[3] S. E. Luria and M. Delbrück, *Arch. Biochem.*, 1: 207, 1942.
[1] This investigation was aided by grants from the Ciba Pharmaceutical Products, Inc., Summit, N. J., and the Josiah Macy, Jr., Foundation, New York, N. Y.
[2] C. D. Kochakian and L. C. Clark, Jr., *Jour. Biol. Chem.*, 143: 795, 1942.
[3] C. D. Kochakian and R. P. Fox, *Endocrinology*, 30: 1033, 1942.
[4] The mice were provided by the Biological Station, Springville, N. Y., through the courtesy of Drs. W. S. Murray and S. G. Warner.
[5] The testosterone propionate (Perandren) was supplied by the Ciba Pharmaceutical Products, Inc., through the kindness of Dr. E. Oppenheimer.
[6] C. D. Kochakian and J. R. Murlin, *Jour. Nutrition*, 10: 437, 1935; *Am. Jour. Physiol.*, 117: 642, 1936; C. D. Kochakian, *Endocrinology*, 21: 750, 1937.

inhibition. Similarly, it was found that cyanide in concentrations of 0.0166M inhibits the oxygen uptake to the extent of 84 to 86 per cent. in normal beets and of 79 to 80 per cent. in tumor beet tissue.

Previous work in this laboratory[1] has shown a differentiation between the healthy part and the tumorous part of the same beet, whereas the above work shows a differentiation between tumorous tissue and the tissue of an entirely healthy non-infected beet root.

Upon addition of cyanide to resorcinol, and *vice versa,* in the case of both healthy and tumorous beet root tissue, there is an increase in inhibition of 6 to 8 per cent. above that due to cyanide alone. These results are summarized in Table 1.

TABLE 1

EFFECT OF RESORCINOL AND CYANIDE ON THE RESPIRATION OF NORMAL AND TUMOR BEET ROOT TISSUE

Substance added	Per cent. inhibition Beet tissue slices	
	Normal	Tumor
Resorcinol	12–14	20–23
Cyanide	84–86	79–80
Resorcinol and cyanide ..	92	86

They suggest: (*a*) Tumors as well as healthy beets may have the following types of respiratory mechanisms: (i) cyanide insensitive system, (ii) resorcinol insensitive system, (iii) cyanide plus resorcinol insensitive system, as well as the corresponding sensitive systems, the relative proportion of the three systems in tumor and healthy tissue being different in each case. (*b*) The inhibitions brought about by cyanide and by resorcinol function to a certain degree independently of each other. (*c*) It appears possible that different active centers of the same enzyme (probably a heavy metal compound) are attacked by both inhibitors but to a different degree.

Experiments are now in progress to determine the nature of this differentiation between tumor and normal tissue.

The authors wish to thank the Carnegie Corporation of New York with whose financial assistance this work is being carried out.

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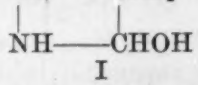
SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SENSITIVE COLOR REACTION FOR THE DETECTION OF URACIL AND CYTOSINE[1,2]

THE author will describe in this paper a modification of the well-known Wheeler and Johnson color test for the detection of the pyrimidines uracil III and cytosine[3] II, which has met with wide application since the date of its discovery in the Yale Laboratory.

The original test is based on the action of bromine on either of these two pyrimidines in aqueous solution, which reacts with them quantitatively with formation of 5,5-dibromoxyhydrouracil I. This hydropyrimidine is characterized by its reactivity towards barium hydroxide with which it reacts in aqueous solution to form (1)—isodialuric acid V and (2)—by rearrangement dialuric[4] acid VI. Both of these pyrimidines give insoluble, deep-purple colored barium salts by neutralization with an excess of barium hydroxide.[5]



I

Bromine water or liquid bromine are necessary reagents for the application of this useful test. There are, however, limitations in applying successfully the color test when uracil and cytosine are present in very small quantities; and furthermore, bromine is not always available in clinical laboratories for experimentation. The author also has experienced unexpected difficulties in detecting uracil and cytosine in the study of natural products containing mixtures of carbohydrates, purines and pyrimidines. He has, therefore, devised a new technique or modification of the original Wheeler and Johnson procedure[3] for testing for these two naturally occurring pyrimidines, which is an improvement on the original experimental procedure.

The new technique calls for only two common laboratory reagents, namely, concentrated hydrochloric acid and superoxol.[6] Advantage is taken, in this new application of the color test, of the known reactivity of hydrogen peroxide towards hydrochloric acid as is expressed in the equation below. The hypochlorous

$$HCl + H_2O_2 = HOCl + H_2O$$

acid formed in this reaction reacts immediately and quantitatively with uracil or cytosine if present in

[1] A. C. Neish and Harold Hibbert, *forthcoming publication.*

[1] Contribution from the Department of Chemistry, Yale University.

[2] "Researches on Pyrimidines," clxxx.

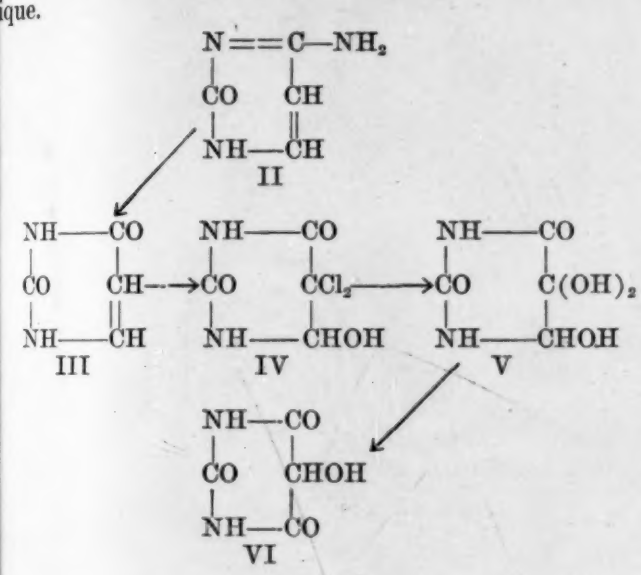
[3] Wheeler and Johnson, *Jour. Biol. Chem.,* 3: 183, 1907.

[4] Behrend and Koch, *Ann.,* 315: 246, 1901.

[5] Behrend and Roosen, *Ann.,* 251: 244, 1889.

[6] Hydrogen peroxide 30 per cent.—Merck and Company, Rahway, N. J.

such a solution with formation of 5,5-dichloroxyhydrouracil IV. This chloro-compound reacts with barium hydroxide in a similar manner as the bromo-pyrimidine I, yielding the characteristic, purple barium salt of dialuric acid VI. The pyrimidine IV has previously been prepared in this laboratory by the action of chlorine water on uracil, and by the oxidation of uracil with potassium chlorate in hydrochloric acid solution.[7] In other words, the original color test for the detection of uracil and cytosine was dependent upon the formation of 5,5-dibromoxyhydrouracil[8] I, while in this new modification of the test 5,5-dichloroxyhydrouracil IV functions as the key pyrimidine reagent. The sensitiveness of the test has been increased by introduction of this new experimental technique.



EXPERIMENTAL PART

The Formation of 5,5-Dichloroxyhydrouracil IV by the Action of Hydrogen Peroxide on Uracil in Hydrochloric Acid Solution:[8] One gram of uracil was dissolved in 20 cc of concentrated hydrochloric acid and 5 cc of superoxol (Merck) added at 0°. Heat was gradually evolved on standing accompanied by evolution of oxygen, but without development of color. After allowing to stand at laboratory temperature for several hours (12 to 15), the solution was then transferred to a glass evaporating dish and exposed to a draft of air in a hood. Beautiful, glistening prisms began to form and increased in quantity until 1.0 g had deposited. They were identified as pure 5,5-dichloroxyhydrouracil[7] IV. The compound contained chlorine and decomposed with effervescence at 218°. This pyrimidine reacted immediately in cold aqueous solution with barium hydroxide yielding a brilliant purple precipitate of the characteristic barium salt of dialuric acid.

Analysis: Calc'd. for $C_4H_4O_3N_2Cl_2 \cdot H_2O$ N, 12.90
Found: N, 12.80, 12.75.

[7] Johnson, *Am. Chem. Jour.*, 40: 26, 1908.
[8] See "Researches on Pyrimidines," clxxviii. Johnson, *Jour. Am. Chem. Soc.*, 65: 1943.

The acid solution remaining after filtering off the crystals of 5,5-dichloroxyhydrouracil IV responded immediately to the Wheeler and Johnson color test for uracil.

Method of Application of the Modified Wheeler and Johnson Color Test for Detection of Uracil and Cytosine: Use a 10–15 cc pyrex beaker for performing the test. Deposit on the bottom of this beaker 5–10 mg of uracil, or the mixed sample to be tested, and moisten with 0.5 or 1.0 cc of superoxol. There will be no apparent change or development of color. Then add from a pipette the same volume of pure concentrated hydrochloric acid (0.5 or 1.0 cc). Heat will be evolved and the uracil will finally dissolve, giving a perfectly clear solution. The mixture is then heated on a boiling water or steam bath when a violent reaction will set in with rapid evolution of oxygen. After subsidence of this reaction continue to heat at 100° until the mixture is reduced to a volume of about 0.5 cc and then cool. If uracil or cytosine were present in the test mixture, an immediate purple coloration or precipitate will be formed by addition of barium hydroxide solution until the reaction mixture shows an alkaline reaction. The whole operation can be conducted in an open laboratory hood, which is not the case when bromine is used in applying the test. Both uracil and cytosine are very sensitive towards hypochlorous acid.

In testing for the presence of uracil or cytosine in solutions of unknown concentration, a known volume should be evaporated almost to dryness before applying the hydrogen peroxide treatment for formation of 5,5-dichloroxyhydrouracil IV.

In Table 1 are recorded the results of a series of color tests applied to different reactants according to the new technique for detecting uracil and cytosine.

TABLE 1

A. *Reactants which gave positive tests confirming the presence of uracil or cytosine:*
   1. Uracil, uracil + thymine, uric acid + uracil, 4-methyluracil + uracil, cytosine hydrochloride, yeast nucleic acid + cytosine, 4-methyluracil + cytosine, glucose and uracil, thymine + cytosine.
   2. 2-Ethylmercapto-6-oxypyrimidine, 2-methylmercapto-6-aminopyrimidine.

B. *Reactants which gave no color test indicating the absence of uracil and cytosine:*
   1. Thymine, uric acid, 4-methyluracil, hydrouracil, 5-bromhydrouracil, 4-phenylcytosine, 4,5-dimethyluracil, yeast nucleic acid, 4-phenyluracil.

C. *Reagents used in applying the above color tests:*
   1. Superoxol, concentrated hydrochloric acid and barium hydroxide.

SUMMARY

(1) Uracil and cytosine are both transformed quantitatively into 5,5-dichloroxyhydrouracil by interaction with superoxol and concentrated hydrochloric acid.

(2) This 5,5-dichloroxyhydrouracil reacts with barium hydroxide immediately at ordinary temperature giving the purple colored barium salt of dialuric acid.

(3) Both uracil and cytosine can be detected successfully in minute quantities by application of the technique discussed in this paper.

TREAT B. JOHNSON

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A NYLON BLOOD AND PLASMA FILTER[1]

THE storage of blood and plasma has become commonplace within the last few years. However, these products frequently develop precipitates despite the use of what appears to be an adequate amount of sodium citrate as the anticoagulant. Although it is desirable that fresh blood be filtered immediately before administration to the patient, this precaution is mandatory when stored blood or plasma is used.

Materials such as cotton gauze, fiber glass braid, glass beads and stainless steel screens have been employed for filtration with varying degrees of success. More recently, Novak[2] has advocated a viscose rayon cloth.

During the past eight months we have been using a nylon[3] filter which has the following desirable characteristics: (1) It removes all clots without clogging; (2) it does not shed lint into the filtrate; (3) it is simple to clean, assemble, and sterilize by autoclaving, and (4) it is inexpensive so that the filter bag may be discarded after being used once.[4] The filter fabric has approximately 30,000 orifices per square inch; a double row of stitches with very fine nylon thread eliminates any danger of leakage. The bag has a filtration surface of approximately 50 sq. cm.[3] This is more than ample for the complete filtration of at least 500 ml of blood or 3,000 ml of plasma. Our failure to observe frequent clogging of this fine mesh filter is probably related to the fact that the nylon filaments are very smooth with round cross sections and aqueous solutions spread over the surface of the fabric without absorbing much moisture. The filtration of blood through the nylon fabric yields results that are comparable to those obtained with a standard 200-mesh screen.[5]

Fig. 1 shows the assembled filter. In use, the cannula is inserted into the appropriate orifice in the

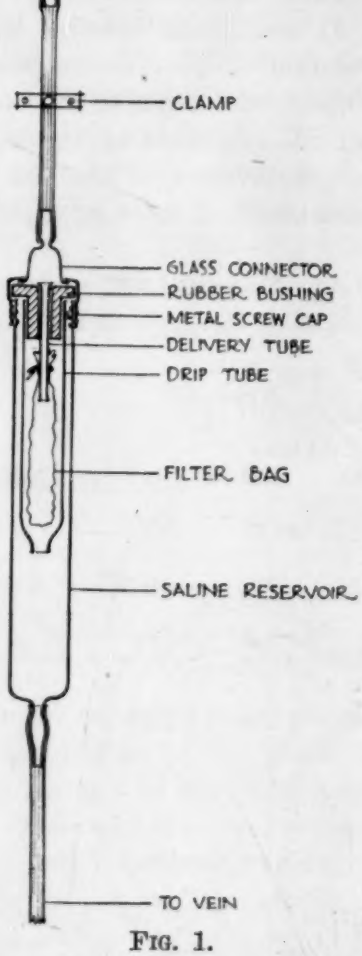

FIG. 1.

rubber-stoppered blood bottle, and the filter with its glass-covered drip tube remains suspended from the inverted bottle. The reservoir, tubing and 18-gauge needle are filled with saline. When the flow into the vein is definitely established, the filter assembly is inserted into the saline reservoir tube and the rate of blood flow is adjusted with the clamp to about 10 ml per minute. The unit simplifies the administration of blood or plasma because it includes the filter, the Murphy drip principle and the saline reservoir for starting the transfusion. No instance of sensitivity to nylon has been observed in over 1,000 blood and plasma infusions. No reactions have followed the administration of plasma in over 200 cases and the incidence of reaction with the use of whole blood has been very low. A further analysis of these data will be presented in a separate communication.

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[1] Presented before the Academy of Surgery, Philadelphia, April 5, 1943, as a contribution from the Philadelphia General Hospital, Solution Room Committee, which also includes Dr. J. H. Clark, Dr. H. I. Hneleski, Dr. J. G. Reinhold and Dr. W. G. Turnbull.

[2] M. Novak, SCIENCE, 97: 248, March, 1943.

[3] The specially woven fine nylon fabric is known as "Hematex." The filter and fabric are available from Frederick H. Rhodes, Madison, N. J.

[4] Due to the current critical value of nylon the bags have been washed and used repeatedly. Immediately after use, the bag is rinsed blood-free in saline. At the end of the day, the accumulated bags are washed thoroughly in Dreft, a sulfonated fatty acid detergent marketed by the Procter and Gamble Company. The bags are then rinsed thoroughly in distilled water, boiled in distilled water for about 15 minutes, air-dried, assembled in sets with tubing and autoclaved. Each filter has been used at least twenty-five times.

[5] I am indebted to Dr. Max Strumia, Bryn Mawr Hospital, Bryn Mawr, Pa., for his kindness in performing this comparative test.